Appendix 4: Comparison of Alternative Methodologies to Calculate Avoided NO_x Emissions

The team completed an analysis of avoided emissions to determine if reductions from energy efficiency and renewable energy sources would offset at least 1.5 lbs/MWh of NO_x emissions. The methodology used in our analysis focused on the ***generation-weighted average of the emissions of fossil fuel fired plants.*** *This is the fourth methodology listed below. We present alternative methodologies for informational purposes.*

Several methods may be employed to model the avoided emissions resulting from energy efficiency or renewable energy measures. These include:

1) A complete grid-system dispatch analysis;
2) A system mix analysis;
3) A surrogate plant analysis; or
4) A generation-weighted average of the emissions of fossil fuel fired plants.

A ***complete grid-system dispatch analysis*** considers the dispatch order and scheduling of specific fossil fuel-fired units (coal, oil, or natural gas) at each facility on the regional grid, providing the most comprehensive estimate of the avoided emissions. An analysis of this type may be based on historical data and/or on a unit dispatch model. The principal unit dispatch models are proprietary.[1]

The dispatch analysis methodology allows the analyst to compare the EERE measures with the actual generation of variably dispatched fossil fuel units for specific time periods. This methodology is very time consuming and resource intensive and is hard to justify for validating an avoided emissions rate already stipulated in a State NO_x trading regulation. However, the additional expense of this detailed approach can be justified to provide more precise estimates of displaced NO_x emissions resulting from a large renewable energy project, such as a large wind farm.[2] In such as case, a large premium obtained for Renewable Energy Certificates may justify the additional expense.

The ***system mix analysis*** uses the generation weighted average of **all** the plants in the electric generating system. In other words, the universe of plants covered by this methodology is not limited to fossil fuel generating plants but also includes nuclear and hydroelectric plants.

A major weakness of the system mix methodology is that it significantly underestimates the emission reductions resulting from EERE projects because it includes nuclear and

[1] However, some utilities will enter into agreements to share such data for analysis purposes on a confidential basis. In addition, some of the new generation tracking systems may provide sufficient data to conduct this analysis.

[2] See National Renewable Energy Laboratory, "Model State Implementation Plan (SIP) Documentation for Wind Energy Purchase in a State with Renewable Energy Set-Aside," http://www.eere.energy.gov/windandhydro/windpoweringamerica/sips.asp

hydroelectric generating plants, which do not produce emissions, in calculating the average displaced emissions. In reality, EERE almost always displaces fossil fuel generation because EERE generally has zero or very low fuel and operating costs, whereas fossil fueled generation has relatively high operating costs. Fossil fueled units also have the ability to vary their output relatively quickly.

In comparison, nuclear power and hydroelectric generation is almost never displaced by EERE measures. Nuclear plants cannot vary their output quickly and have relatively low marginal operating costs. Hydroelectric plants also have low marginal operating costs, and therefore, generation from other renewable energy rarely displaces that from hydroelectric power. In addition, hydroelectric plants have externally imposed storage limits and flow constraints that restrict the ability to meet unpredicted load changes. For these reasons, the generation at renewable energy plants and reductions in demand from energy efficiency programs will displace generation almost entirely at fossil fueled plants in the period from now through 2012.

The ***surrogate plant analysis*** calculates the emissions of the next new plant or unit that is likely to be added to the electric grid as a basis for determining what emissions would be avoided if the demand were reduced by energy efficiency measures or displaced by renewable energy generation. In New Jersey, under prevailing fuel prices and air quality regulations, the most likely new plant would be a combined cycle natural gas plant with best available NO_x control technology. With this approach, the calculated NO_x reductions would be below the 1.5 lbs/MWh stipulated in the NJ NO_x trading regulations. This approach is unrealistic in the short term because actual generation and energy efficiency displacement is spread across a wide range of fossil fueled generating units, some of which have relatively high NO_x emission rates. The surrogate plant methodology may provide a reasonable estimate of the long-term avoided emissions if current trends continue. However, the actual mix of plants may be very different in the future depending on fuel prices and public policy.

A fourth methodology – and the one relied upon by the project team – is an analysis based on the ***generation-weighted average of the emissions of fossil fuel fired plants.*** This methodology is a reasonable approximation of the marginal emission rate, without the time and cost of a complete grid-system dispatch analysis.

Two independent analyses were conducted based on the generation-weighted average emissions of fossil fueled plants. Resource Systems Group, Inc. (RSG) performed the first analysis and relied on emissions and generation data from the EPA's eGRID 2002 database.[3] The emissions data in eGRID 2002 is based on emissions data collected in 2000. The list of facilities used for this assessment and their associated NO_x emission rates, generation, and primary fuel are included in Table 1.

The team included small facilities in the analysis even though such facilities do not influence the estimate significantly. In addition, it should be noted that although the

[3] Emissions & Generation Resource Integrated Database (eGRID) 2002.

primary fuel is listed for each facility, many facilities operate subordinate units that burn other fuels, often contributing to varying emission rates among a fuel group.

Based on the eGRID 2002 data, the team estimated the generation-weighted NO_x emissions for both annual operation and ozone-season operations. The annual avoided NO_x emission rates are 2.7 lbs/MWh, and the ozone season rates are 2.2 lbs/MWh. Both of these rates are well above the 1.5 lbs/MWh avoided emissions rate that is currently stipulated in the NJ NO_x trading regulations. Even removing several of the largest and most inefficient coal burning facilities from the analysis is not enough to drop the estimate below 1.5 lbs/MWh. Therefore, the project team believes that 1.5 lbs/MWh is a reasonable (and probably conservative) value for avoided emissions credit in 2005. However, it should be noted that this emission rate is expected to decline in the future as older, dirtier generating plants are replaced by more efficient plants with superior NO_x control technology.

New Jersey DEP provided the second analysis,[4] and the project team ultimately relied on this analysis for the calculations of emission reductions contained in the body of this report. The NJ DEP analysis was similar to the RSG analysis because both methodologies were based on the generation weighted average of emissions from fossil fueled plants in New Jersey. The two major differences were that the DEP analysis relied on: (1) plants operating in 2004 (compared to the 2000 data in the eGRID/RSG analysis); and (2) plants with a capacity of more than 15 MW (compared to all fossil fuel plants in the RSG analysis).

The NJ DEP data provided an estimate of 1.85 lbs/MWh for the average avoided emissions rate in 2004. DEP also projected future average avoided ozone season NO_x emission rates based on data about new plants completed, under construction, or expected to be retired. In addition, the NJ data included information projecting the installation of NO_x control systems. Based on this information, DEP estimated the generation-weighted NO_x emissions rates to be 1.65 lbs/MWh in 2005, 1.24lbs/MWh in 2007, and 0.97lbs/MWh in 2008.

Both the RSG and DEP analyses validate the use of 1.5 lbs/MWh for 2005. The analysis team recommends the use of the DEP estimates beyond 2005 as they are based on more recent data and incorporate projected changes in control technology and the fossil fueled generation mix. These DEP estimates beyond 2005 have been incorporated into the projections for each of the four alternative scenarios in the report.

[4] Tom McNevin, Bureau Air Quality Planning, NJ DEP, Personal Communication, September 2005.

Table 1: Fossil Fueled Generation Units Used In the Generation Weighted Analysis of Variably Dispatched Plants in New Jersey.

Name	Fuel	Capacity Factor	Capacity (MW)	Annual Net Generation (MWh)	Ozone Season Net Geneation (MWh)	Nox Rate Annual (lbs/MWh)	Nox Rate Ozone Season (lbs/MWh)
Chambers Cogeneration LP	Coal	57%	285	1,433,629	597,345	0.8	0.8
Hudson Generating Station	Coal	31%	1229	3,307,562	1,570,699	5.6	4.3
Logan Generating Plant	Coal	56%	230	1,126,726	469,469	0.9	0.9
Mercer Generating Station	Coal	44%	768	2,926,302	1,376,294	8.9	6.2
B L England	Coal	30%	484	1,256,331	550,443	8.3	6.5
Deepwater	Coal	17%	259	377,442	193,346	5.9	5.2
Howard Down	Coal	10%	71	62,270	35,368	10.4	10.0
Bayonne Generating Station	Distillate Oil	0%	43	596	516	16.8	8.1
Carlis Corner	Distillate Oil	1%	84	9,532	5,896	7.6	5.1
Cedar Station	Distillate Oil	3%	63	18,508	10,075	4.2	3.2
Middle Station	Distillate Oil	1%	80	7,408	3,686	7.3	6.1
Missouri Avenue	Distillate Oil	1%	56	6,503	3,686	8.0	5.9
National Park Generating Station	Distillate Oil	0%	19	146	142	9.1	3.9
Werner	Distillate Oil	0%	159	5,100	2,125	2.3	2.3
Forked River	Natural Gas	7%	77	46,764	22,135	5.6	4.9
Anheuser Busch Inc Newark Brewery	Natural Gas	66%	13	75,513	31,464	1.3	1.3
Asbury Park Press Inc	Natural Gas	53%	1	6,044	2,518	1.6	1.6
Aventis Pharmaceuticals	Natural Gas	81%	4	26,529	11,054	1.7	1.7
Bayonne Cogen Plant	Natural Gas	84%	192	1,409,971	587,488	0.4	0.4
Bayville Central Facility	Natural Gas	27%	1	3,008	1,253	1.7	1.7
Bergen Generating Station	Natural Gas	22%	765	1,485,866	840,246	1.2	0.9
Bristol Myers Squibb Co	Natural Gas	89%	10	74,373	30,989	1.4	1.4
Burlington Generating Station	Natural Gas	3%	807	228,102	157,538	0.9	0.7
Calpine Newark Inc	Natural Gas	48%	65	271,413	113,089	0.4	0.4
Calpine Parlin Inc	Natural Gas	32%	141	389,001	162,084	0.2	0.2
Camden Cogen LP	Natural Gas	70%	157	969,174	403,823	0.5	0.5
Cumberland	Natural Gas	5%	99	40,545	19,619	1.9	1.6
Eagle Point Cogeneration	Natural Gas	87%	225	1,712,749	713,645	1.0	1.0
Edison Generating Station	Natural Gas	3%	510	114,502	71,238	3.8	2.5
Essex Generating Station	Natural Gas	4%	596	186,746	103,326	2.9	2.2
Fiber Mark Technical Specialties Inc	Natural Gas	33%	2	5,801	2,417	1.8	1.8
Gilbert	Natural Gas	5%	606	243,950	101,646	1.4	1.8
Glenn Gardner	Natural Gas	1%	157	16,837	7,016	2.1	2.1
Green Tree Chemical Technologies Inc	Natural Gas	76%	5	30,141	12,559	2.2	2.2
Hoffmann Laroche Inc	Natural Gas	61%	12	63,694	26,539	1.4	1.4
Hunterdon Cogeneration Facility	Natural Gas	82%	4	29,322	12,218	1.2	1.2
Kenilworth Energy Facility	Natural Gas	85%	30	224,139	93,391	1.2	1.2
Kms Crossroads	Natural Gas	78%	7	47,629	19,846	1.5	1.5
Lakewood Cogeneration LP	Natural Gas	26%	239	550,345	229,311	0.1	0.1
Linden Cogen Plant	Natural Gas	64%	762	4,289,494	1,787,289	0.4	0.4
Linden Generating Station	Natural Gas	5%	778	346,952	201,210	1.2	1.6
Lowe Paper Co Division Of Simkins Industries	Natural Gas	44%	3	11,574	4,822	1.4	1.4
M&M Mars	Natural Gas	82%	9	63,277	26,365	1.7	1.7
Merck Rahway Power Plant	Natural Gas	47%	11	44,164	18,402	1.0	1.0
Mickleton Station	Natural Gas	3%	71	21,574	14,313	4.3	2.7
Milford Power LP	Natural Gas	0%	33	203	85	1.4	1.4
Montclair Cogeneration Facility	Natural Gas	91%	4	32,656	13,607	0.9	0.9
Newark Bay Cogeneration Project	Natural Gas	52%	135	619,417	258,090	1.1	1.1
Novartis Pharmaceuticals	Natural Gas	59%	3	14,550	6,063	1.5	1.5
Pedricktown Cogeneration Plant	Natural Gas	19%	135	228,139	95,058	0.4	0.4
Pharmacia Corp	Natural Gas	18%	5	7,434	3,097	1.8	1.8
Prime Energy LP	Natural Gas	72%	83	521,052	217,105	1.1	1.1
Roche Vitamins Inc	Natural Gas	81%	45	320,477	133,532	1.2	1.2
Rowan University	Natural Gas	53%	2	6,909	2,879	1.8	1.8
Sayreville	Natural Gas	1%	463	21,511	8,963	1.5	2.9
Sayreville Cogeneration Facility	Natural Gas	55%	430	2,063,072	859,613	1.2	1.2
Schering Corp Cogeneration Facility	Natural Gas	88%	8	63,086	26,286	2.0	2.0
Schweitzer Mauduit International Inc	Natural Gas	29%	4	9,056	3,773	1.6	1.6
Sherman Avenue	Natural Gas	6%	113	61,976	32,070	0.9	1.2
Trigen Trenton Energy Co	Natural Gas	83%	12	87,464	36,443	2.9	2.9
University Medicine Dentistry	Natural Gas	89%	11	81,669	34,029	1.4	1.4
Vineland Cogeneration Plant	Natural Gas	19%	53	88,095	36,706	0.4	0.4
West Station	Oil	4%	27	10,169	5,721	13.5	10.0
Kearny Generating Station	Residual Oil	0%	1165	39,974	29,376	4.1	3.5
Sewaren Generating Station	Residual Oil	4%	576	216,431	136,897	1.7	1.3